

# St. Louis Tunnel Hydraulic Controls - Stage 2 Rico-Argentine Mine Site – Operable Unit OU01 Rico, Colorado

## Technical Specifications

St. Louis Tunnel Hydraulic Controls – Stage 2  
Rico-Argentine Mine Site – Operable Unit OU01  
Rico, Colorado

Technical Specifications  
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Reference Specifications From Phase I Solids Repository Project

Note: Requirements in the following referenced Specification Sections shall be as applicable to the St. Louis Tunnel Hydraulic Controls – Stage 2 Work as interpreted by the Engineer or the Owner's Onsite Representative.

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SECTION 03 30 00  
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide cast-in-place concrete for the St. Louis Tunnel discharge intake structure as shown on the Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Submittals: Section 01 33 00.
- B. Delivery, Storage, and Handling 01 66 10.

1.03 REFERENCES

- A. American Concrete Institute (ACI):
  - a. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - b. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete
  - c. 301: Specifications for Structural Concrete for Buildings
  - d. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
  - e. 304.2R: Placing Concrete by Pumping Methods
  - f. 305R: Hot Weather Concreting
  - g. 306R: Cold Weather Concreting
  - h. 308: Standard Practice for Curing Concrete
  - i. 309R: Guide for Consolidation of Concrete
  - j. 318: Building Code Requirements for Reinforced Concrete
  - k. 350: Code Requirements For Environmental Engineering Concrete Structures (for use as a guideline only)

- B. American Society for Testing and Materials International (ASTM):
- a. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
  - b. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - c. A36: Standard Specification for Carbon Structural Steel
  - d. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
  - e. C33: Standard Specification for Concrete Aggregates
  - f. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
  - g. C40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
  - h. C87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
  - i. C94: Standard Specification for Ready-Mixed Concrete
  - j. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50-mm] Cube Specimens)
  - k. C123: Standard Test Method for Lightweight Particles in Aggregate
  - l. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
  - m. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
  - n. C143: Standard Test Method for Slump of Hydraulic Cement Concrete
  - o. C150: Standard Specification for Portland Cement
  - p. C171: Standard Specification for Sheet Materials for Curing Concrete
  - q. C172: Standard Practice for Sampling Freshly Mixed Concrete

- r. C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- s. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- t. C260: Standard Specification for Air-Entraining Admixtures for Concrete
- u. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- v. F1554: Standard Specification for Anchor Bolts (Anchor Rods), Steel, 36, 55 and 105-ksi Yield Strength
- w. F2329: Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

C. Concrete Reinforcing Steel Institute (CRSI):

- a. Manual of Standard Practice for Reinforced Concrete Construction

D. The Society for Protective Coatings (SSPC):

- a. Surface Preparation Standards and Specifications

#### 1.04 SUBMITTALS

A. Provide submittals in accordance with Section 01 33 00.

B. Product Data:

- a. Manufacturer's specifications and instructions including Material safety Data Sheets (MSDS) for admixtures and curing materials. Manufacturer's certification of compatibility of all admixtures.
- b. For each formulation of concrete proposed, provide concrete mix designs and laboratory 7-day and 28-day compressive tests, or submit test results of 7- and 28-day compressive tests of the mix where the same mix has been used on two previous projects in the past twelve months.
- c. Prior to fabrication or shipment of reinforcing and accessories, provide, and receive approval of, Shop Drawings. Shop drawings shall indicate bending diagrams, assembly diagrams, splicing and lapping of rods, shapes, dimensions and details of

bar reinforcing and accessories. Shop Drawings shall show all openings and penetrations that pass through concrete construction. The approval of Shop Drawings will be for conformance to the design intent and will not relieve the Contractor of responsibility for errors, omissions or the accuracy of his own dimensions. Shop Drawings and details shall conform to ACI 315, ACI 350, and ACI 318.

C. Test and Evaluation Reports

- a. Provide results of drying shrinkage tests from trial concrete mixes by the Contractor's testing laboratory.

D. Manufacturers' Instructions

- a. Provide epoxy bonding compound manufacturer's specific instructions for use. Provide manufacturer's data sheets as to suitability of product to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

E. Field Quality Control Submittals

- a. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate.

1.05 QUALITY ASSURANCE

A. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:

- a. ACI 350, "Code Requirements For Environmental Engineering Concrete Structures."

B. Where provisions of pertinent codes and standards conflict with this Specification, the more stringent provisions govern.

C. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the Work.

D. Perform concrete work in conformance with ACI 301 unless otherwise specified.

- E. Do not use admixtures, including calcium chloride, which will cause accelerated setting of cement in concrete.
- F. Do not place concrete until design mix, material tests and trial concrete batch mix compression test results are accepted by the Engineer.
- G. Employ an independent testing laboratory, acceptable to the Engineer, to develop concrete mix designs and testing. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent.
- H. The Contractor shall employ an independent testing laboratory, acceptable to the Engineer, to test conformity of materials to specifications. Concrete testing shall be performed by an ACI Concrete Field Technician, Grade I or equivalent. Allow free access to obtain test samples.
  - a. Methods of Sampling and Testing:
    - (a) Fresh Concrete Sampling: ASTM C172
    - (b) Specimen Preparation: ASTM C31
    - (c) Compressive Strength: ASTM C39
    - (d) Air Content: ASTM C231
    - (e) Slump: ASTM C143
- I. Acceptance of Structure: Acceptance of completed concrete work requires conformance with dimensional tolerances, appearance and strength as indicated or specified.
- J. Hot weather concrete to conform to ACI 305R and as specified herein.
- K. Cold weather concrete to conform to ACI 306R and as specified herein.
- L. Reject concrete delivered to job site that exceeds the time limit or temperature limitations specified.
- M. Do not place concrete in water or on frozen or uncompacted ground.
- N. Workability
  - a. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.

- b. Concrete mix shall be designed to reflect the method of transportation to the project site.
- c. Adjust the proportions to secure a plastic, cohesive mixture, and one that is within the specified slump range.
- d. To avoid unnecessary changes in consistency, obtain the aggregate from a source with uniform quality, moisture content, and grading. Handle materials to minimize variations in moisture content that would interfere with production of concrete of the established degree of uniformity and slump.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage, and handling shall be in accordance with Section 01 66 10.
- B. Provide as specified herein.
- C. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.
- D. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations or not having a complete delivery batch ticket.

#### 1.07 SITE CONDITIONS:

- A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C31 and as specified herein.

### PART 2 – PRODUCTS

#### 2.01 MATERIALS:

- A. Cement:
  - a. Portland Cement, ASTM C150, Type V
- B. Fly Ash:
  - a. Provide fly ash conforming to the following requirements:
  - b. Class F fly ash conforming to ASTM C 618 for chemical and physical properties.
    - (a) Supplemental requirements in percent:



- (b) Maximum carbon content: 3 percent
- (c) Maximum sulfur trioxide (SO<sub>3</sub>) content: 4 percent
- (d) Maximum loss on ignition: 3 percent
- (e) Maximum water requirement (as a percent of control): 100 percent
- (f) Fineness, maximum retained on No. 325 sieve: 25 percent
- c. Fly ash used in concrete that contacts potable water shall be certified as meeting the requirements of ANSI/NSF 61.

C. Silica Fume:

- a. Silica fume mineral admixture shall be the dry compacted or slurry form and shall meet the requirements of ASTM C1240. Silica Fume shall be considered to be a cementitious material. Application rate shall be 7 percent by weight of cement, unless indicated otherwise.
- b. Products:
  - (a) BASF Building Systems; Rheomac SF100.
  - (b) W.R. Grace & Company; Force 10,000 D.
  - (c) Sika Corp.; Sikacrete 950 DP.
  - (d) Xypex crystalline waterproofing materials: Xypex Admix C-500
    - i. Xypex Admix must be added to concrete mix at time of batching.
    - ii. Dosage Rate: Under normal conditions, the crystalline waterproofing powder shall be added to the concrete mix 3% by weight of Portland cement content.

D. Fine Aggregates:

- a. Clean, sharp, natural sand conforming to requirements of ASTM C33 with a fineness modulus between 2.50 and 3.0.

E. Coarse Aggregate:

- a. Well graded crushed stone, natural rock conforming to requirements of ASTM C33.

- b. Limit deleterious substances in accordance with ASTM C33, Table 3, Severe Weathering Regions, limit clay lumps not to exceed 1.0 percent by weight, and limit loss when tested for soundness using magnesium sulfate to 12 percent.

F. Reinforcing Steel

- a. Reinforcing steel bars shall conform to the requirements of ASTM A615, Grade 60. Steel bars shall be deformed except for sizes less than 3/8-inch and specified dowels or spirals.

2.02 MIXES:

- A. Conform to ASTM C94, except as modified by these Specifications.
- B. Air entrainment is required for concrete exposed to freeze-thaw cycles and to maintain concrete workability
- C. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318. The resulting mix shall not conflict with limiting values specified in the following table.

<b>28-Day Minimum Compressive Strength (psi)</b>	<b>Minimum Cementitious Content (lbs per C.Y.)</b>	<b>Maximum Water/ Cement Ratio</b>	<b>Air content (%)</b>
4,500	600	0.45	7.5

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine the subgrade and the conditions under which work is to be performed and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions are corrected to comply with specified subgrade conditions in a manner acceptable to the Engineer.

3.02 MIXING AND TRANSPORTING CONCRETE:

- A. General: Conform to concreting procedures set forth in ASTM C94, ACI 304R, CSA A23.1/A23.2 and as specified herein.
  - a. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature and homogeneity.

- b. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after the addition of water, whichever occurs first.
- c. Do not add water at the jobsite unless permitted by the Engineer. If it is necessary to add water to obtain the specified slump, add water per ASTM C94, but do not exceed the maximum water content in the reviewed concrete design mix. Added water shall be incorporated by additional mixing of at least 35 revolutions.
- d. Do not add water to concrete containing high range water reducing admixture. Do not add water to concrete in delivery equipment not acceptable for mixing.
- e. Keep a record showing time and place of each pour of concrete, together with transit-mix delivery slips certifying the contents of the pour.
- f. Discharge of concrete shall be completed within the limits set out in the following table.

<b>Maximum Time to Concrete Discharge</b>	
<b>Concrete Temperature</b>	<b>Limit</b>
Over 90 Degree F	Remove concrete from jobsite and discard concrete
86 to 90 Degree F	45 minutes
81 to 85 Degree F	60 minutes
70 to 80 Degree F	75 minutes
Below 70 Degree F	90 minutes

### 3.03 CONCRETE ACCEPTANCE:

- A. Accept or reject each batch of concrete delivered to the point of agitator or mixer truck discharge. Sign delivery batch tickets to indicate concrete acceptance.
- B. Reject concrete delivered without a complete concrete delivery batch ticket as specified herein.
- C. Reject concrete not conforming to Specifications before discharging into the forms.

### 3.04 PREPARATION AND COORDINATION:

- A. Contractor shall notify the Owner's Onsite Representative of readiness to place concrete in any portion of the Work a minimum of five (5) working days prior to concrete placement. Failure to provide this notification will be cause for delay in placing until observations can be completed.

- B. Compact the subgrade and/or bedding. Saturate the subgrade approximately eight hours before placement and sprinkle ahead of the placement of concrete in areas where vapor barrier is not used. Remove standing water, mud, and foreign matter before concrete is deposited.

### 3.05 CONCRETE PLACEMENT:

- A. Placement shall conform to ACI 304RCSA A23.1/23.2 as modified by these Specifications.
- B. Do not place concrete until free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work.
- C. Do not allow concrete to fall freely in forms to cause segregation (separation of coarse aggregate from mortar). Limit maximum free fall of concrete to 4 feet (1,220 mm). Do not move concrete horizontally more than four feet from point of discharge. Space points of deposit not more than eight feet apart.
- D. Consolidate concrete using mechanical vibrators operated within the mass of concrete and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.
- E. Conduct vibration to produce concrete of uniform texture and appearance, free of honeycombing, streaking, cold joints or visible lift lines.
- F. Pumping Concrete:
  - a. Conform to the recommendations of ACI 304.2R except as modified herein.
  - b. Base pump size on rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lift, and slump of concrete.
  - c. Use pipe with inside diameter of at least three times the maximum coarse aggregate size, but not less than 2 inches (50 mm).
  - d. Do not use aluminum pipes for delivery of concrete to the forms.

### 3.06 CURING AND PROTECTION:

- A. General:
  - a. Perform hot weather concreting in conformance with ACI 305RCSA A23.1/A23.2 and as specified herein when the

ambient atmospheric temperature is 80 degrees F (27 degrees C) or above.

- b. Perform cold weather concreting in conformance with ACI 306RCSA A23.1/A23.2 except as specified herein.
- c. Concrete required to be moist cured shall remain moist for the entire duration of the cure. Repeated wetting and drying cycles of the curing process will not be allowed.

B. Curing Duration:

- a. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered as part of the curing system, provided that wooden forms are kept continuously moist. Keep continuously moist for not less than 72 hours.
- b. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.
- c. Avoid rapid drying at the end of the final curing period.

C. Curing Methods:

- a. Water Curing: Use water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing by any of the following methods:
  - (a) Keeping the surface of the concrete continuously wet by ponding or immersion.
  - (b) Continuous water-fog spray or sprinkling.
  - (c) Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4 inch (100 mm) lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface.

### 3.07 REINFORCING STEEL

#### D. Detailing and Fabrication

- a. Reinforcing steel shall be detailed and fabricated in accordance with, and to the tolerances of, ACI 315 unless otherwise noted on the Construction Drawings.
- b. Reinforcing as delivered shall be free of loose mill scale, loose rust, paint, grease, oil, dirt, mud or any other foreign material which will prevent or reduce bonding.
- c. Fabricated reinforcement shall be free of twists, kinks or unscheduled bends. Such defects shall be cause for rejection.
- d. Reinforcing shall be bent cold without inducing gractures or cracking in the steel.

#### E. Reinforcement Accessories

- a. Bar supports, tie wire and accessories shall be supplied by the Contractor.
- b. Bar supports of standard types and sizes shall conform to the Concrete Reinforcing Steel Institute Specifications.
- c. Tie wire shall be black annealed wire, not less than No. 16 guage, of suitable quality for securing reinforcement in place.

#### F. Reinforcing Steel Installation

- a. Installation of reinforcing steel shall be in accordance with ACI 318 and the reviewed Shop Drawings. Reinforcing steel shall not be bent or straightened in a manner injurious to the steel. Bars with kinks or bends not indicated on the Shop Drawings shall not be used in the work. The use of heat to bend or straighten reinforcing steel is authorized only if approved in advance by the Engineer or Owner's Onsite Representative. Before placement, reinforcing steel shall be thoroughly cleaned of loose or flaky rust, mill scale, or coatings of any foreign substance that would reduce or destroy the bond. Reinforcing steel reduced in section shall not be used in the work. Steel shall be placed where indicated on the Shop Drawings. In the event of a substantial work delay, previously placed reinforcing steel left for future bonding shall be inspected and cleaned. Field splices, if required, shall be made with a wire-tied lap of not less than the number of par diameters indicated in ACI Code 318 for the proper class of splice as shown on the Shop Drawings. As

an alternate, mechanical connectors used in strict conformance to the manufacturer's recommendations may be used with prior approval of the Engineer or Owner's Onsite Representative in lieu of the lapped and tied splices.

- b. Welding shall not be performed on reinforcing steel unless shown on the Shop Drawings.

**G. Reinforcing Steel Supports**

- a. Reinforcement shall be securely held in position by spacers, chairs, or other approved supports. The type, number and spacing shall conform to ACI 315. They shall be plastic tipped where the finished concrete will be exposed.
- b. Reinforcement shall be securely tied at intersections and splices, as required by the CRSI's "Manual of Standard Practice for Reinforced Concrete Construction", to maintain their position during work by other trades and during concrete placement. Tying shall be done using black annealed wire, with wire tie ends pointing away from the form. Tack welding of reinforcing or of reinforcing steel assemblies shall not be permitted.
- c. When mats and footings are cast on mud slabs, the reinforcing may be supported on spacers or chairs; however, when slabs, mats or footings are cast on grade the reinforcing shall be supported on precast concrete blocks or other approved device. Such supports shall be spaced at intervals required by the reinforcing size to maintain the specified minimum concrete cover over the steel bars.

**END OF SECTION**

## SECTION 31 23 10

### EARTHWORK

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. This Section includes materials, testing, and earthwork for construction of the St. Louis Tunnel Hydraulic Controls – Stage 2 (Revised) and associated permanent earthwork.
- B. Work under this Section includes:
  - a. Preparation and submittal of plans and test results.
  - b. Excavation for: structures, site drainage, and selective soil removals from slopes adjacent to collapsed portion of St. Louis Tunnel.
  - c. Hauling, placing and compacting (if required) excess excavation on-site.
  - d. Preparation and protection of subgrade surfaces.
  - e. Removal, replacement and compaction of existing gravel roadway surfacing on main haul road.
  - f. Procurement, placement and compaction of embankment fill, crushed rock, and riprap.
- C. See Section 02 41 00 for disposal of concrete, wood, steel cable, and other non-earthen debris that may be encountered in required excavations.
- D. Trenching and backfill for hydraulic controls piping is specified in Section 31 23 33.
- E. Placement and compaction of gravel roadway surfacing is specified in Section 32 15 45.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Submittals: Section 01 33 00.
- B. Subsurface Investigations: Section 02 32 00.
- C. Demolition: Section 02 41 00.



- D. Site Clearing: Section 31 10 00.
- E. Site Preparation: Section 31 22 00.
- F. Trenching, Backfilling and Compacting: Section 31 23 33.
- G. Gravel Roadway Surfacing: Section 32 15 45.

### 1.03 REFERENCE STANDARDS

- A. ASTM International (ASTM)
  - a. ASTM C33: Standard Specification for Concrete Aggregate.
  - b. ASTM C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  - c. ASTM C535: Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - d. ASTM D422: Standard Test Method for Particle-Size Analysis of Soils.
  - e. ASTM D698: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>2</sup>) (600 kN-m/m<sup>2</sup>).
  - f. ASTM D1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
  - g. ASTM D4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  - h. ASTM D4254: Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  - i. ASTM D4718 – Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
  - j. ASTM D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
  - k. ASTM D7382: Standard Test Methods for Determination of Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibratory Hammer.

- B. Standard test methods referenced in the above ASTM methods shall be considered as referenced herein.
- C. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, latest edition.

#### 1.04 DEFINITIONS

- A. Treatment Solids.
  - a. Treatment solids are precipitated and settled oxy-hydroxide sludges resulting from prior lime addition to dissolved metals-bearing water from the St. Louis Tunnel that precipitated and settled primarily in the upper ponds (Ponds 12, 13, 14, 15 and 18) at the St. Louis Ponds System.
  - b. Treatment solids removed by others from Pond 18 are also present in the remaining portion of the Interim Drying Facility (IDF) at the St. Louis Ponds site.
- B. Calcines.
  - a. Calcines are silt- to sand-sized particles comprised primarily of iron oxide (with other common to less abundant accessory minerals) resulting from the historic on-site processing of pyrite ore by heating (i.e., calcining). These materials are typically characterized by distinctive dark reddish to purple color.
  - b. Calcines were placed by others within the historic Ponds 16/17 area which is now covered by the remaining portion of the IDF.

#### 1.05 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00.
- B. Submit a report from a testing laboratory acceptable to the Engineer verifying that the materials intended for use on the Project conform to the requirements specified in Part 2, Materials of this Section 31 23 10.
- C. Reports and permits.
  - a. Materials Reports:
    - a) Name and location of materials source.
    - b) Date of sample.
    - c) Grain-size analysis to include minus No. 200 sieve percentage by wash method and Atterberg limits analysis.

- b. Field Evaluation Reports:
  - a) Provide reports for all QC testing performed by Contractor.
  - b) Field density testing reports: Provide results from field density testing of compacted embankment fill.
  - c) Grain-size analysis.
  - d) Atterberg limits analysis.
  - e) Laboratory compaction characteristics of soils.
  - f) Water content.
- c. Owner required Control of Work (CoW) Permits.

#### 1.06 SITE CONDITIONS

- A. Existing facilities, structures, and utilities, and the approximate location of prior structures at the site, are shown on the Drawings in accordance with available surveys and records.
- B. See Section 02 32 00 regarding available geotechnical field investigation and laboratory testing data; logs of borings and test pits and laboratory test results not included in the Phase 1 Solids Repository Project Contract Documents will be provided to Contractor upon request.

#### 1.07 TESTING FOR COMPACTION

- A. The Contractor shall test for compaction at the frequency described below.
- B. The density of soil as compacted in place shall be determined by the sand cone method, ASTM D1556, or by nuclear methods, ASTM D6938. Testing for compaction shall be performed at a frequency of not less than one test per 200 cubic yards (cy) of fill placed, but not less than two tests at any single fill placement greater than 100 cy but less than 400 cy. Engineer or Owner's Onsite Representative reserves the right to confirm the adequacy of compaction with additional testing if necessary. Only fill for which relative compaction or relative density criteria are specified in this Section 31 23 00 will be tested.
- C. When additional testing is determined necessary due to a test location failing to meet the compaction requirements, testing at a greater frequency and impacts to the progress of the Work from the additional testing will not be a basis for additional compensation to Contractor.

- D. Laboratory compaction control criteria shall be determined by ASTM D698, ASTM D4253 and ASTM D4254, or ASTM D7382 at the discretion of the Engineer or Owner's Onsite Representative. Where oversize particles are present in the proposed backfill material, the compaction test results for maximum dry density and optimum water content shall be adjusted if necessary in accordance with ASTM D4718.
- E. Determine the "relative density" of cohesionless soils as defined in ASTM D4253 and ASTM D4254.
- F. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density as determined by ASTM D698, ASTM D4254, or ASTM D7382.
- G. Compaction shall be deemed to comply with the Specifications when no test falls below the specified relative compaction or relative density.

#### 1.08 BLASTING

- A. No blasting shall be permitted during construction of any of the Work.

#### 1.09 DISPOSAL OF EXCESS EXCAVATED MATERIALS

- A. All excess earthen material generated during earthwork activities shall be placed at the Project Site at locations acceptable to the Owner or Owner's Onsite Representative and in conformance with the requirements of this Section 31 23 10.

### **PART 2 - MATERIALS**

#### 2.01 EMBANKMENT FILL

- A. Embankment fill shall be placed as backfill behind the inlet structure wing walls and around the manhole, and as necessary to establish stormwater drainage contours, all as shown on the Construction Drawings, and at such other areas as may require embankment fill if directed or approved by the Owner's Onsite Representative.
- B. Embankment fill shall be excavated colluvial and/or waste rock material from required excavations that is free from all organic matter, roots, concrete, wood and other debris, rocks larger than four (4) inches in the greatest dimension, and any other objectionable or deleterious material as determined by the Owner's Onsite Representative.
- C. Embankment fill shall not be borrowed from treatment solids, calcines or calcines-impacted soils encountered at the St. Louis Ponds site.

- D. Embankment fill shall not classify as Pt, OH, OL, ML, MH, or CH in accordance with the Unified Soil Classification System (USCS).

## 2.02 CRUSHED ROCK

- A. Crushed rock shall be placed on prepared subgrades beneath structures and as bedding for riprap at locations and to the dimensions shown on the Construction Drawings.
- B. Aggregates for crushed rock shall be imported hard, dense, durable, angular crushed stone or crushed gravel.
- C. Crushed rock gradation shall comply with the requirements for No. 3 concrete aggregate in CDOT Specifications, Section 703, as shown in Table 703-2. Following are the gradation limits as taken from Table 703-2:

Crushed Rock	
Sieve Size	Percent Passing By Weight (%)
2½ - inch	100
2 - inch	90-100
1½ - inch	35-70
1 - inch	0-15
½ - inch	0-5

These gradation limits shall be met prior to placement in the Work.

## 2.03 RIPRAP

- A. Riprap shall consist of hard, dense, durable stone, angular in shape and resistant to weathering. Rounded stone or boulders shall not be used as riprap material. The stone shall have a specific gravity of at least 2.5. Each piece shall have its greatest dimension not greater than three times its least dimension. Material used for riprap may be approved by the Engineer or Owner's Onsite Representative if, by visual inspection, the rock is determined to be sound and durable. The Engineer or Owner's Onsite Representative may require the Contractor to furnish laboratory results if, in the Engineer's or Owner's Onsite Representative's opinion, the material is marginal or unacceptable. At the request of the Engineer or Owner's Onsite Representative, the Contractor shall furnish laboratory test results indicating that the material meets the requirements for abrasion resistance (per ASTM

C535, 50% loss max.) and/or compressive strength (AASHTO T24, 2500 psi min.).

- B. Riprap shall conform to the gradation requirements in the following table for D<sub>50</sub> 6-inch or D<sub>50</sub> 12-inch nominal size riprap:

<b>Riprap</b>			
<b>Stone Size D<sub>50</sub><sup>1</sup> (inches)</b>	<b>Percent of Material Smaller Than Typical Stone<sup>2</sup></b>	<b>Typical Stone Dimensions<sup>3</sup> (inches)</b>	<b>Typical Stone Weight<sup>4</sup> (pounds)</b>
6	70-100	12	85
	50-70	9	35
	35-50	6	10
	2-10	2	0.4
12	70-100	21	440
	50-70	18	275
	35-50	12	85
	2-10	4	3

<sup>1</sup> d<sub>50</sub> = Nominal stone size

<sup>2</sup> Based on typical rock mass

<sup>3</sup> Equivalent spherical dimension

<sup>4</sup> Based on specific gravity = 2.5

Control of gradation will be by visual inspection by Owner's Onsite Representative. If Engineer or Owner's Onsite Representative believe riprap does not conform to the required gradation then Contractor shall supply mechanical equipment, a sorting site and labor as needed to check gradation at direction of Owner's Onsite Representative. Such testing, if required, shall be at Contractor's expense.

## 2.04 WATER FOR EARTHWORK PURPOSES

- A. Water used for earthwork operations shall be clean and free from injurious amounts of oil, acid, organic matter, or other deleterious substances.
- B. Contractor shall provide all equipment and facilities for obtaining water from the Dolores River for construction purposes and all means of conveying the water to the points of use.

## PART 3 - EXECUTION

### 3.01 EXCAVATION

- A. Excavations shall be made in accordance with the requirements of this Section 31 23 10 as necessary to construct the Work.
- B. Excavations shall conform with the requirements of 29CFR1926 Subpart P – Excavations of OSHA regulations, BP Defined Practices for Excavation and Ground Disturbance, Owner required permits, and other applicable federal, state, or local rules and regulations as necessary to provide safe and stable conditions at all times adjacent to and within the excavations.
- C. Maintain excavations free of standing water by interim grading, ditching, sumping and pumping, or by other means selected by the Contractor.

### 3.02 LIMITS OF EXCAVATION

- A. Excavations shall be made to the lines, grades, and elevations shown on the Construction Drawings, or as directed by the Owner's Onsite Representative in the case of over-excavation ordered by the Owner's Onsite Representative.
- B. Excavations shall be within 0.1 foot of the required lines and grades unless allowed otherwise in writing on a case-by-case basis by the Owner's Onsite Representative.
- C. Over-excavation for any cause shall be backfilled with embankment fill unless directed otherwise by the Owner's Onsite Representative. Any such backfill shall be placed and compacted as specified in this Section 31 23 10.
- D. The Contractor shall bear all costs for correcting areas over-excavated for the Contractor's convenience and unauthorized over-excavated areas. Such over-excavation and re-fill shall not be cause for any additional payment.

### 3.03 EXCESS EXCAVATION

- A. Required excavations may generate some amount of material in excess of that required for use in the Work. This excess material shall be hauled and used for other work at the site or hauled to the North Laydown Area of the site and placed in a stockpile(s) acceptable to the Owner's Onsite Representative.
- B. Excess excavated material shall be placed and compacted as specified for the work into which it is to be placed. No compaction is required if the material is stockpiled.

### 3.04 SELECTIVE REMOVAL AND GRADING WITHIN COLLAPSED PORTION OF TUNNEL

- A. All selective removal and grading within the collapsed portion of the St. Louis Tunnel shall be as directed by the Owner's Onsite Representative. Anticipated removals and grading are shown by reaches on the Construction Drawings as a general guide to the Contractor, but actual removals and grading shall be as directed by the Owner's Onsite Representative.
- B. Do not remove any materials that in the judgment of the Owner's Onsite Representative may result in destabilizing the existing walls of the collapsed portion of the tunnel or adjacent ground or slopes.
- C. See Section 3.03 of this Section No. 31 23 10 for disposition of excess excavated material.

### 3.05 PREPARATION OF SUBGRADE

- A. Upon reaching subgrade elevation in areas to receive fill proof-roll or proof-tamp the subgrade with equipment and in a manner acceptable to the Owner's Onsite Representative. If loose or soft areas are identified, the Owner's Onsite Representative may direct that additional compaction, or removal, replacement and compaction of the loose or soft material be performed. Any such work shall be compensated at the unit prices for excavation and placement and compaction of embankment fill.
- B. Scarify and re-compact subgrades beneath structures as required on the Construction Drawings.
- C. Coordinate with Owner's Onsite Representative for inspection of compacted subgrade by Engineer or Owner's Onsite Representative at least 24 hours prior to placement of backfill on prepared subgrade. Do not place backfill until inspection has been completed.
- D. Protect compacted subgrades from becoming saturated, frozen, loosened, or otherwise damaged until backfill is placed.

### 3.06 GENERAL REQUIREMENTS FOR PLACING AND COMPACTING BACKFILL

- A. Place all classes of backfill at the locations and to the lines and grades as shown on the Construction Drawings. Placed and compacted backfill shall be within 0.1 foot of the required lines and grades unless allowed otherwise in writing on a case-by-case basis by the Owner's Onsite Representative or Engineer.
- B. Backfill containing more than 12 percent fines and classifying as plastic (as defined under the Unified Soil Classification System) shall not be placed when the ambient air temperature at the time of placement is less than 35°F,



or when the ambient air temperature is less than 40°F and has been falling for more than four hours.

- C. Do not place frozen fill unless specifically authorized by the Owner's Onsite Representative in writing for each and every instance of such placement. Owner's Onsite Representative may deny authority to place frozen fill at his discretion. If frozen fill is to be placed, Contractor shall thoroughly disaggregate the fill prior to placement or compaction, without disturbing previously placed fill or the subgrade, all to the satisfaction of the Owner's Onsite Representative. Any work to prepare frozen material to place as fill, even though authorized, shall be performed for no additional payment.
- D. Do not place fill on frozen subgrade or previously placed and compacted backfill (subsequently frozen) unless specifically authorized by the Owner's Onsite Representative in writing for each and every instance of such placement. Engineer or Owner's Onsite Representative may deny authority to place fill on frozen subgrade at his discretion. If authorized, the Contractor shall prepare frozen subgrade or previously placed and compacted backfill (subsequently frozen) by scarifying and re-compacting if directed by, and to the satisfaction of, the Owner's Onsite Representative. Any work to prepare frozen subgrade or previously placed and compacted backfill to receive new fill, even though authorized, shall be performed for no additional payment.
- E. Select equipment and employ means and methods to achieve the compaction or consolidation requirements in paragraphs 3.07 through 3.10 of this Section 31 23 10.
- F. Compact or consolidate fill to the specified requirements in paragraphs 3.07 through 3.9 below. Compact or consolidate by using mechanical compaction. Utilize equipment of the type, size, weight, horsepower, and vibratory energy (if applicable) as necessary to achieve compaction or consolidation without excessive passes. Water jetting shall not be used under any circumstances.
- G. Compact or consolidate material placed within 12 inches of the outer surface of piping, conduit or other buried utilities and connections by hand tamping only.
- H. Do not use any axle-driven or tractor-drawn compaction equipment within 3 feet of structures.

### 3.07 PLACING AND COMPACTING EMBANKMENT FILL

- A. Placing Embankment Fill:
  - a. Place embankment fills to the lines and grades shown on the Construction Drawings. Place in maximum 12-inch loose, horizontal lifts and compact each lift as specified herein. If necessary to achieve the required compaction, Contractor shall

place thinner loose lifts prior to compaction at no additional cost to Owner.

B. Compacting Embankment Fill:

- a. Fill material with greater than 12 percent passing the No. 200 sieve shall be compacted to at least 95 percent of the maximum dry density and within minus two (-2) to plus two (2) percent of the optimum water content, when tested in accordance with ASTM D 698 (standard Proctor).
- b. Fill material with less than 5 percent passing the No. 200 sieve shall be compacted to at least 70 percent of relative density when tested in accordance with ASTM D 4253 and ASTM D 4254 and with sufficient water to prevent bulking; to 90 percent of the maximum index density when tested in accordance with ASTM D 4253; or to 95 percent of the maximum density and within the range of water content for effective compaction as determined when tested in accordance with ASTM 7382, at the discretion of the Owner's Onsite Representative.
- c. Fill material with 5 to 12 percent passing the No. 200 sieve shall be compacted to at least 95 percent of maximum dry density when tested in accordance with ASTM D 698; or 70 percent of relative density when tested in accordance with ASTM D 4253 and ASTM D 4254; to 90 percent of the maximum index density when tested in accordance with ASTM D 4253; or to 95 percent of the maximum density as determined when tested in accordance with ASTM D 7382, at the discretion of the Owner's Onsite Representative; moisture content shall be within minus two (-2) to plus two (2) percent of optimum water content when compaction is controlled per ASTM D 698, sufficient to prevent bulking when compaction is controlled by ASTM D 4253 and ASTM D 4254, and within the range for effective compaction as determined when tested in accordance with ASTM D 7382.
- d. Maintain uniform moisture content throughout the lift. Insofar as practicable, add water to the material at the site of excavation if water content is below specified limits. Supplement as necessary by sprinkling the backfill material. Aerate material containing excessive moisture by blading, discing, or harrowing to hasten the drying process.
- e. If testing indicates that the placement moisture content and/or percent compaction do not meet the Specifications, or when the methods of compaction specified are not being followed, Contractor shall immediately make adjustments in procedures as

necessary to obtain the specified results or implement the required compaction methods. This shall not relieve the Contractor of the responsibility for meeting the compaction requirements in this Section on all fill placed and shall not be the basis for any additional compensation.

- f. Materials not meeting the specified moisture content and/or percent compaction, or that were not placed in accordance with the methods specified shall be reworked until acceptable results are obtained. Reworking may include removal, re-handling, reconditioning, rerolling, or combinations of these procedures. The Contractor shall not be entitled to additional compensation by reason of any work required to achieve the placement moisture content and percent compaction, or to implement the methods specified in these Specifications.

### 3.08 PLACING AND COMPACTING CRUSHED ROCK

- A. Place crushed rock in maximum 6-inch lifts; do not place by free-fall exceeding 2 feet.
- B. Do not use water jetting, sluicing or flooding during placement.
- C. Compact crushed rock with equipment acceptable to the Owner's Onsite Representative to achieve a dense, non-yielding surface beneath areas upon which concrete structures or riprap are to be placed.

### 3.09 PLACING AND CONSOLIDATING RIPRAP

- A. Place riprap by equipment directly at the location of placement. Riprap shall not be dropped from a height greater than 3 feet. Spreading by hand tools, loader, excavator or dozer is allowed.
- B. Riprap shall be placed so as to avoid segregation and to achieve interlocking among the different size stones to result in a stable condition. Where practical, riprap shall be track-walked by small crawler dozer to promote consolidation. Otherwise, consolidate these materials by tamping and jostling with a loader or excavator bucket during and/or after placing.

END OF SECTION

## SECTION 31 23 33

### TRENCHING, BACKFILLING AND COMPACTING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. This section includes materials and installation for reinforced concrete pipe (RCP) tunnel discharge piping at locations shown on the Construction Drawings.
- B. Work under this Section includes:
  - a. Preparation and submittal of plans and test results.
  - b. Trench excavations for installation of tunnel discharge piping.
  - c. Placement and compaction of pipe cover zone backfill.
  - d. Placement and compaction of pipe zone backfill.
  - e. Placement and compaction of pipe bedding.
- C. See Section 02 41 00 for disposal of concrete, wood, steel cable, and other non-earthen debris that may be encountered in required excavations.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Submittals: Section 01 33 00.
- B. Subsurface Investigations: Section 02 32 00.
- C. Demolition: Section 02 41 00.
- D. Site Clearing: Section 31 10 00.
- E. Site Preparation: Section 31 22 00.
- F. Earthwork: Section 31 23 10.
- G. Reinforced Concrete Pipe 33 41 00.

##### 1.03 REFERENCE STANDARDS

- A. ASTM International (ASTM)
  - a. ASTM C33: Standard Specification for Concrete Aggregate

- b. ASTM D422: Standard Test Method for Particle-Size Analysis of Soils.
- c. ASTM D698: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>2</sup>) (600 kN-m/m<sup>2</sup>).
- d. ASTM D1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
- e. ASTM D4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- f. ASTM D4254: Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- g. ASTM D4718 – Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.
- h. ASTM D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- i. ASTM D7382: Standard Test Methods for Determination of Dry Unit Weight and Water Content Range for Effective Compaction of Granular Soils Using a Vibratory Hammer.

- B. Standard test methods referenced in the above ASTM methods shall be considered as referenced herein.

#### 1.04 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00.
- B. Submit a report from a testing laboratory acceptable to the Owner's Onsite Representative verifying that the materials intended for use on the Project conform to the requirements specified in Part 2, Materials of this Section 31 23 33.
- C. Materials Reports:
  - a. Name and location of materials source.
  - b. Date of sample.
  - c. Grain-size analysis to include minus No. 200 sieve percentage by wash method.

- d. Atterberg limits analysis.
- D. Field Evaluation Reports:
  - a. Provide reports for all Quality Control (QC) testing performed by Contractor.
  - b. Field density testing reports: Provide results from field density testing of compacted trench backfill.
  - c. Grain-size analysis.
  - d. Atterberg limits.
  - e. Laboratory compaction characteristics of soils.
  - f. Water content.
- E. Owner required Control of Work (CoW) permits.

#### 1.05 SITE CONDITIONS

- A. Existing facilities, structures, and utilities, and the approximate location of prior structures at the site, are shown on the Drawings in accordance with available surveys and records.
- B. See Section 02 32 00 regarding available geotechnical field investigation and laboratory testing data; logs of borings and test pits and laboratory test results not included in the Phase 1 Solids Repository Project Contract Documents will be provided to Contractor upon request.

#### 1.06 TESTING FOR COMPACTION

- A. The Contractor shall test for compaction at the frequency described below.
- B. The density of soil as compacted in place shall be determined by the sand cone method, ASTM D1556, or by nuclear methods, ASTM D6938. Testing for compaction shall be performed at a frequency of not less than one test per 200 cubic yards (cy) of fill placed, but not less than two tests at any single fill placement greater than 100 cy but less than 400 cy. Only fill for which relative compaction or relative density criteria are specified in this Section 31 23 33 will be tested.
- C. When additional testing is determined necessary due to a test location failing to meet the compaction requirements, testing at a greater frequency and impacts to the progress of the Work from the additional testing will not be a basis for additional compensation to Contractor.

- D. Laboratory compaction control criteria shall be determined by ASTM D698, ASTM D4253 and ASTM D4254, or ASTM D7382 at the discretion of the Owner's Onsite Representative. Where oversize particles are present in the proposed backfill material, the compaction test results for maximum dry density and optimum water content shall be adjusted if necessary in accordance with ASTM D4718.
- E. Determine the relative density of cohesionless soils per ASTM D4253 and ASTM D4254.
- F. "Relative density" of cohesionless soils is as defined in ASTM D4253 and ASTM D4254.
- G. "Relative compaction" is the ratio, expressed as a percentage, of the in-place dry density to the laboratory maximum dry density as determined by ASTM D698, ASTM D4254, or ASTM D7382.
- H. Compaction shall be deemed to comply with the Specifications when no test falls below the specified relative compaction or relative density.

#### 1.07 BLASTING

- A. No blasting shall be permitted during construction of any of the Work.

#### 1.08 DISPOSAL OF EXCESS EXCAVATED MATERIALS

- A. Any excess earthen material generated during trenching and backfilling activities shall be graded out in the area of work as acceptable to the Owner's Onsite Representative, utilized in other earthwork at the Project Site or placed at the locations identified for excess excavated material and in conformance with the applicable requirements of Section 31 23 10.

### PART 2 - MATERIALS

#### 2.01 PIPE COVER ZONE BACKFILL

- A. Pipe cover zone backfill shall be placed as backfill in the pipe cover zone of the trenched portion of tunnel discharge system piping as shown on the Construction Drawings.
- B. Pipe cover zone backfill shall be excavated colluvial and/or waste rock material from required excavations anywhere on the St. Louis Ponds site or from adjacent borrow areas that is free from all organic matter, roots, concrete, wood and other debris, rocks larger than four (4) inches in the greatest dimension, and any other objectionable or deleterious material as determined by the Owner's Onsite Representative.

- C. Pipe cover zone backfill shall not include treatment solids or calcines as defined in Section 31 23 10.
- D. Pipe cover zone backfill shall not classify as Pt, OH, OL, ML, MH, or CH in accordance with the Unified Soil Classification System (USCS).

## 2.02 PIPE ZONE BACKFILL AND PIPE BEDDING

- A. Pipe zone backfill and pipe bedding shall be placed in trench excavations for tunnel discharge piping at locations as shown on the Construction Drawings.
- B. Pipe zone backfill and pipe bedding shall be Class 6 ABC imported, processed material as supplied by McStone Aggregates, LLC, CDOT Class 1 Structure Backfill as supplied by McStone Aggregates, LLC, or approved equal or alternative.
- C. Pipe zone backfill and pipe bedding material finer than the minus No. 40 sieve shall be non-plastic.
- D. The pre-approved grading requirements for pipe zone backfill and pipe bedding are as follows:

<b>Pipe Zone Backfill and Pipe Bedding – Class 6 ABC</b>	
<b>Sieve Size</b>	<b>Percent Passing By Weight (%)</b>
$\frac{3}{4}$ - inch	100
No. 4	30-65
No. 8	25 - 55
No. 200	3-12

<b>Pipe Zone Backfill and Pipe Bedding – CDOT Class 1 Structure Backfill</b>	
<b>Sieve Size</b>	<b>Percent Passing By Weight (%)</b>
$\frac{3}{4}$ - inch	100
No. 4	30-100
No. 50	10-60
No. 200	5-20

These gradation limits shall be met both prior to and after placement in the Work.

## 2.03 WATER FOR EARTHWORK PURPOSES

- A. Water used for earthwork operations shall be clean and free from injurious amounts of oil, acid, organic matter, or other deleterious substances.



- B. Contractor shall provide all equipment and facilities for obtaining water for construction purposes and all means of conveying the water to the points of use.

## PART 3 - EXECUTION

### 3.01 SLOPING, SHEETING, SHORING, AND BRACING OF TRENCHES

- A. Trenches shall have sloping, sheeting, shoring, and bracing conforming to 29CFR1926, Subpart P--Excavations, OSHA requirements, BP Defined Practices for Excavation and Ground Disturbance, Owner required permits, and all other requirements of local and state agencies having jurisdiction for trenching and excavation safety.

### 3.02 TRENCH AND BACKFILL ZONE WIDTHS

- A. Trench and backfill zone widths as shown on the Construction Drawings are minimum widths to meet the requirements of design. These minimum widths are also neat lines for measurement and payment. Contractor may construct a wider trench and wider backfill zones at his own cost but only with the concurrence of the Owner's Onsite Representative and the Engineer.

### 3.03 TRENCH EXCAVATION

- A. Excavate the trench to the lines and grades shown on the Construction Drawings with allowance for pipe thickness, sheeting, and shoring if used, and for pipe bedding.
- B. If the trench is excavated below the required grade without the direction or approval of the Owner's Onsite Representative, refill the part of the trench excavated below the grade with pipe cover zone backfill. Place the refilling material over the full width of trench in compacted layers not exceeding six (6) inches deep to the established trench excavation grade. Any such backfill shall be placed and compacted as specified in this Section 31 23 33. The Contractor shall bear all costs for correcting areas over-excavated for the Contractor's convenience and unauthorized over-excavated areas. Such over-excavation and re-fill shall not be cause for any additional payment.
- C. Provide and maintain means and devices to remove and dispose of water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until placing and compacting the pipe cover zone backfill has been completed. These provisions shall apply during both working and non-working hours, including lunch time, evenings, weekends, and holidays. Dispose of the water to Pond 15 or where directed by the Owner's Onsite Representative. Do not drain trench water through the pipeline under construction unless specifically

authorized in writing by the Engineer in response to an RFI submitted by the Contractor.

- D. Provide and maintain good surface drainage around temporary excavation slopes to direct surface runoff away from the excavations. In no case shall water be allowed to pond at the top of excavations along the alignment. Slopes shall also be protected against erosion. Erosion along the slopes will result in sloughing and could lead to a slope failure.
- E. Conform to BP Defined Practice for Excavation and Ground Disturbance, and federal, state, and local codes governing the safe loading of trenches with excavated material.
- F. Stockpiling of materials shall not be permitted within five (5) feet of the top of temporary slopes, or a distance equal to the depth of the excavation, whichever is greater.

#### 3.04 GENERAL REQUIREMENTS FOR PLACING AND COMPACTING BACKFILL

- A. Place all classes of backfill to the lines and grades as shown on the Construction Drawings. Placed and compacted backfill shall be within 0.1 foot of the required lines and grades unless allowed otherwise in writing on a case-by-case basis by the Owner's Onsite Representative.
- B. Backfill containing more than 12 percent fines and classifying as plastic (as defined under the Unified Soil Classification System) shall not be placed when the ambient air temperature at the time of placement is less than 35°F, or when the ambient air temperature is less than 40°F and has been falling for more than four hours.
- C. Do not place frozen fill unless specifically authorized by the Owner's Onsite Representative in writing for each and every instance of such placement. Owner's Onsite Representative may deny authority to place frozen fill at his discretion. If frozen fill is to be placed, Contractor shall thoroughly disaggregate the fill prior to placement or compaction, without disturbing previously placed fill or the subgrade, all to the satisfaction of the Owner's Onsite Representative. Any work to prepare frozen material to place as fill, even though authorized, shall be performed for no additional payment.
- D. Do not place fill on frozen subgrade or previously placed and compacted backfill (subsequently frozen) unless specifically authorized by the Owner's Onsite Representative in writing for each and every instance of such placement. Engineer or Owner's Onsite Representative may deny authority to place fill on frozen subgrade at his discretion. If authorized, the Contractor shall prepare frozen subgrade or previously placed and compacted backfill by scarifying and re-compacting if directed by, and to the satisfaction of, the Owner's Onsite Representative. Any work to prepare frozen subgrade or

previously placed and compacted backfill to receive new fill, even though authorized, shall be performed for no additional payment.

- E. Select equipment and employ means and methods to achieve the compaction requirements in paragraph 3.06.
- F. Compact fill to the specified requirements in paragraph 3.06 below. Compact by using mechanical compaction. Utilize equipment of the type, size, weight, horsepower, and vibratory energy (if applicable) as necessary to achieve compaction without excessive passes and without damaging the pipe or conduit within the trench. Water jetting shall not be used under any circumstances.
- G. Compact material placed within 12 inches of the outer surface of piping, conduit or other buried utilities and connections by hand tamping only.

### 3.05 INSTALLING BURIED PIPING

- A. Grade the bottom of the trench to the line and grade to which the pipe is to be laid, with allowance for pipe thickness. Remove hard spots that would prevent a uniform thickness of bedding. Place the specified thickness of pipe bedding material over the full width of trench. Grade the top of the pipe bedding ahead of the pipe laying to provide firm, continuous, uniform support along the full length of pipe. Before laying each section of the pipe, check the grade and correct any irregularities.
- B. Excavate spaces to allow removal of pipe handling slings. Fill excavated areas with the pipe bedding material specified.
- C. After pipe has been bedded, place pipe zone material simultaneously on both sides of the pipe, in maximum 6-inch lifts, keeping the level of backfill the same on each side. Carefully place the material around the pipe so that the pipe barrel is completely supported and that no voids or uncompacted areas are left beneath the pipe. Use particular care in placing material on the underside of the pipe to prevent lateral movement during subsequent backfilling. The Contractor may utilize greater lift depths if it can be demonstrated that the specified compaction levels are being obtained.
- D. Compact each lift in the pipe zone to the relative compaction specified in paragraph 3.06 in this Section 31 23 33.
- E. Push the backfill material carefully onto the backfill previously placed in the pipe zone. Do not permit free fall of the material until at least two (2) feet of cover is provided over the top of the pipe. Do not drop sharp, heavy pieces of material directly onto the pipe or the tamped material around the pipe. Do not operate heavy equipment over the pipe until at least three (3) feet of backfill has been placed and compacted over the pipe.

3.06 COMPACTING PIPE COVER BACKFILL, PIPE ZONE BACKFILL AND PIPE BEDDING

- A. Compact pipe cover zone backfill, pipe zone backfill and pipe bedding as specified in this paragraph 3.06, except as specified differently in paragraph 3.05 of this Section 31 23 33.
- B. Fill material with greater than 12 percent passing the No. 200 sieve shall be compacted to at least 95 percent of the maximum dry density and within minus two (-2) to plus two (2) percent of the optimum water content, when tested in accordance with ASTM D 698 (Standard Proctor).
- C. Fill material with less than 5 percent passing the No. 200 sieve shall be compacted to at least 70 percent of relative density when tested in accordance with ASTM D 4253 and ASTM D 4254 and with sufficient water to prevent bulking; to 90 percent of the maximum index density when tested in accordance with ASTM D 4253; or to 95 percent of the maximum density and within the range of water content for effective compaction as determined when tested in accordance with ASTM 7382, at the discretion of the Owner's Onsite Representative.
- D. Fill material with 5 to 12 percent passing the No. 200 sieve shall be compacted to at least 95 percent of maximum dry density when tested in accordance with ASTM D 698; or 70 percent of relative density when tested in accordance with ASTM D 4253 and ASTM D 4254; to 90 percent of the maximum index density when tested in accordance with ASTM D 4253; or to 95 percent of the maximum density as determined when tested in accordance with ASTM D 7382, at the discretion of the Owner's Onsite Representative; moisture content shall be within minus two (-2) to plus two (2) percent of optimum water content when compaction is controlled per ASTM D 698, sufficient to prevent bulking when compaction is controlled by ASTM D 4253 and ASTM D 4254, and within the range for effective compaction as determined when tested in accordance with ASTM D 7382.
- E. Maintain uniform moisture content throughout the lift. Insofar as practicable, add water to the material at the site of borrow if water content is below specified limits. Supplement as necessary by sprinkling the backfill material. Aerate material containing excessive moisture at the borrow or stockpile by blading, discing, or harrowing to hasten the drying process.
- F. If testing indicates that the placement moisture content and/or percent compaction do not meet the Specifications, or when the methods of compaction specified are not being followed, Contractor shall immediately make adjustments in procedures as necessary to obtain the specified results or implement the required compaction methods. This shall not relieve the Contractor of the responsibility for meeting the compaction requirements in

this Section on all fill placed and shall not be the basis for any additional compensation.

- G. Materials not meeting the specified moisture content and/or percent compaction, or that were not placed in accordance with the methods specified shall be reworked until acceptable results are obtained. Reworking may include removal, re-handling, reconditioning, re-compacting, or combinations of these procedures. The Contractor shall not be entitled to additional compensation by reason of any work required to achieve the placement moisture content and percent compaction, or to implement the methods specified in these Specifications.

END OF SECTION

## SECTION 33 05 13

### MANHOLES AND STRUCTURES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Furnish all labor, materials, and equipment required, and install precast concrete manhole, access hatch, and appurtenances as shown on the Construction Drawings and as specified herein.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Submittals: Section 01 33 00.
- B. Reinforced Concrete Pipe: Section 33 41 00.

##### 1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
  - a. A48 - Standard Specification for Gray Iron Castings.
  - b. A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - c. C33 - Standard Specification for Concrete Aggregates.
  - d. C150 - Standard Specification for Portland Cement.
  - e. C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
  - f. C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
  - g. C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
  - h. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
  - i. C913 - Standard Specification for Precast Concrete and Wastewater Structures.
  - j. D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials.

- B. American Concrete Institute (ACI)
  - a. ACI 318 - Building Code Requirements for Reinforced Concrete.
  - b. ACI 350R - Environmental Engineering Concrete Structures.
- C. Occupational Safety and Health Administration (OSHA).
- D. Army Corps of Engineers (CRD).
- E. NSF International (NSF).

#### 1.04 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00.
- B. Submit to the Engineer, Shop Drawings, product data, materials of construction, and details of installation. Submittals shall include at least the following:
  - a. Base section, base slab, concrete footer, riser section(s), and custom (angled) precast manhole lid with certificate indicating compliance with ASTM C478.
  - b. Pipe connections to manhole.
  - c. Access hatch and frame, Bilco Model JD-ALH20 cast flush in custom (angled), non-skid precast manhole lid as shown on the Construction Drawings.
  - d. Method of repair for minor damage to precast concrete sections.
  - e. Gaskets or preformed flexible joint sealant.
- C. Design Data
  - a. Precast concrete structures:
    - a) Sectional plan(s) and elevations showing dimensions and reinforcing steel placement.
    - b) Structural calculations including assumptions.
    - c) Concrete design mix per Section 00 33 00 or approved equal.
    - d) All structures to be designed for H-20 structural design load.

## 1.05 QUALITY ASSURANCE

- A. All material shall be new.
- B. Materials' quality, manufacturing process, and finished sections are subject to inspection and approval by the Engineer. Inspection may be made at place of manufacture, at work site following delivery, or both.
- C. Materials will be examined for compliance with ASTM standards, this Section and approved manufacturer's drawings. Additional inspection criteria shall include: appearance, dimensions(s), blisters, cracks, and soundness.
- D. Materials shall be rejected for failure to meet any requirements specified herein. Rejection may occur at place of manufacture, at work site, or following installation. Mark for identification rejected materials and remove from work site immediately. Rejected materials shall be replaced at no cost to Owner.
- E. Repair minor damage to precast concrete sections by approved method, if repair is authorized by Engineer.

## PART 2 - PRODUCTS

### 2.01 PRECAST CONCRETE SECTIONS

- A. Additive: A crystalline waterproofing additive (Xypex) must be added to the concrete mixture of all precast structures. This product addition will meet the following requirements:
  - a. Products: Xypex crystalline waterproofing materials: Xypex Admix C-500.
  - b. Mixture: Xypex Admix must be added to concrete mix at time of batching.
  - c. Dosage Rate: Under normal conditions, the crystalline waterproofing powder shall be added to the concrete mix 3% by weight of Portland cement content.
  - d. Application: Xypex Admix shall be added to the concrete mix at time of batching. Thorough blending of the Xypex Admix throughout the concrete mix is essential for correct performance of the product and, therefore, care should be taken to ensure that a homogeneous mixture is obtained.
  - e. Concrete Batching and Mixing on Precast Batch Plant for Pan Type Mixer: Add Xypex Admix to the coarse and fine aggregate, then mix thoroughly for 2 - 3 minutes before adding the cement



and water. The total concrete mass should be blended using standard practices.

- B. Manhole Sections: Precast concrete base section, riser section(s), transition top section(s), and custom (angled), non-skid precast manhole lid shall, except where noted, conform to ASTM C 478 and meet the following requirements:
- a. Bottom slab thickness: equal to or greater than the riser wall thickness or custom (angled) precast manhole lid thickness, whichever is greater, 8 inches minimum.
  - b. Base, riser and transition top sections shall have tongue and groove joints.
  - c. Cured by an approved method and shall not be shipped nor subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 5 days after fabrication and/or repair, whichever is longer.
  - d. Design precast concrete base, riser, transition top, and custom (angled), non-skid precast manhole lid for a minimum AASHTO H-20 loading plus earth load. Calculate earth load with a unit weight of 130 pcf.
  - e. Mark date of manufacture, name and trademark of manufacturer on the inside of each precast section.
  - f. Provide lifting lugs or holes in each precast section for proper handling.
  - g. Incorporate only Type V Sulfate Resistant Portland Cement in precast concrete mix design.

## 2.02 JOINTING PRECAST MANHOLE SECTIONS AND STRUCTURES

- A. Seal tongue and groove joints of precast manhole sections with either rubber O-ring gasket or preformed flexible joint sealant. O-ring gasket shall conform to ASTM C 443. Preformed flexible joint sealant shall be Kent Seal No. 2 by Hamilton-Kent; Rubber-Nek by K.T. Snyder Company.
- B. Completed joint shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

## 2.03 ACCESS HATCH & FRAME

- A. Back coat all surfaces of aluminum access hatch frame in contact with concrete with 20 mils coal tar epoxy.

- B. Cast hatch frame in lid to provide flush top surface free of steps or ridges.
- C. Provide Recessed Padlock Hasp option. Owner will supply padlock and keys.
- D. Provide two (2) each additional removable square key wrenches and removable cover plugs as spares.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Manhole and Structure Installation:
  - a. Manhole shall be constructed to the dimensions shown on the Construction Drawings. Protect all work against flooding and flotation.
  - b. Set manhole base grade so that a maximum grade adjustment of 8 inches is required to bring the manhole frame and cover to final grade.
  - c. Provide precast concrete custom (angled), non-skid precast manhole lid to match finished slope and grade of road adjacent to structure.
  - d. Set precast concrete barrel sections and structures plumb with a 1/4-inch maximum out of plumb tolerance allowed. Seal joints of precast barrel sections with either a rubber O-ring set in a recess or preformed flexible joint sealant in sufficient quantity to fill 75% of the joint cavity. Fill the inside joint with non-shrink mortar and finished flush with the adjoining surfaces. Caulk the inside of any leaking barrel section joint with lead wool or non-shrink grout.
  - e. Allow joints to set for 24 hours before backfilling unless a shorter period is specifically approved by the Owner's Onsite Representative or the Engineer.
  - f. Plug holes in the concrete barrel sections required for handling with a non-shrinking grout or non-shrinking grout in combination with concrete plugs. Finish flush on the inside.
  - g. Backfill carefully and evenly around manhole sections.

### 3.02 CLEANING

- A. Thoroughly clean new manhole of all silt, debris, and foreign matter of any kind prior to final inspection.

END OF SECTION

## SECTION 33 41 00

### REINFORCED CONCRETE PIPE

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. This section includes construction of reinforced concrete pipe for St. Louis Tunnel discharge conveyance, including appurtenances normally installed as a part of these systems. Construction may include surface preparation; trench excavation; shoring; dewatering; lay, align and join pipe installation of appurtenances; bedding and backfilling; surface restoration; and other related work as specified herein or in related sections as noted in paragraph 1.02 of this Section 33 41 00.

##### 1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Submittals: Section 01 33 00.
- B. Delivery, Storage, and Handling 01 66 10.
- C. Earthwork: Section 31 23 10.
- D. Trenching, Backfilling and Compacting: Section 31 23 33.

##### 1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - a. A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  - c. C150 - Standard Specification for Portland Cement.
  - d. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
  - e. C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
  - f. C827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.

- g. C990, Standard Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
  - h. C1479, Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installation.
  - i. C1619, Standard Specifications for Elastomeric Seals for Joining Concrete Pipe.
  - j. C1628, Standard Specifications for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets.
- B. U.S. Bureau of Reclamation (USBR): M-1, Standard Specifications for Reinforced Concrete Pressure Pipe.
  - C. Army Corps of Engineers (CRD).
  - D. NSF International (NSF).

#### 1.04 SUBMITTALS

- A. Provide submittals in accordance with Section 01 33 00.
- B. Details of fittings and specials shall be furnished for approval by Engineer.
- C. Unless otherwise specified, Contractor shall submit to Engineer for approval Shop Drawings showing the exact dimension of the joints including the permissible tolerances for the size of pipe being furnished and the size, type and locations of gasket materials. Approval of the joint detail drawings shall not relieve Contractor of any responsibilities to meet all of the requirements of these Specifications, or of the responsibility for correctness of Contractor's details.
- D. Contractor shall cooperate with Engineer in obtaining and providing samples of all specified materials if requested by Engineer or Owner.
- E. Contractor shall submit certified laboratory test certificates for all items required in this section.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery, storage, and handling shall be in accordance with Section 01 66 10.
- B. Responsibility for Material:
  - a. Contractor shall be responsible for all materials intended for the Work that are delivered to the construction site and accepted by Contractor. Payment shall not be made for materials found to be

defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at Contractor's expense.

- b. Contractor shall be responsible for the safe and proper storage of such materials.

C. Pipe Acceptance:

- a. In addition to any deficiencies not covered by ASTM C76 for non-pressurized concrete pipe, concrete pipe that has any of the following visual defects will not be accepted.
  - a) Porous spots on either the inside or the outside surface of a pipe having an area of more than ten (10) square inches and a depth of more than one-half (1/2) inch.
  - b) Pipe which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by Engineer.
  - c) Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.
  - d) Pipe that has been damaged during shipment or handling even if previously approved before shipment.
  - e) Concrete pipe, at delivery to the job site, shall have cured and reached the design strength as required by ASTM C76 for non-pressurized pipe, and be at least five days old.
- b. Acceptance of the pipe at point of delivery shall not relieve Contractor of full responsibility for any defects in materials due to workmanship.

D. Pipe Handling:

- a. Pipe and accessories furnished by Contractor shall be delivered to, unloaded, and distributed at the site by Contractor. Each pipe shall be unloaded adjacent to or near the intended laying location.
- b. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.
- c. Pipe shall be handled in a manner intended to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall

be repaired by Contractor, at Contractor's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to Engineer. Physical damage to the pipe or accessory shall be repaired by Contractor at Contractor's expense, and in a manner satisfactory to Engineer.

- E. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. General: Precast concrete pipe with Crystalline Waterproofing Additive (Xypex), which conforms to ASTM C76 for non-pressurized pipe, or to any other requirement specified herein. Any pipe that does not comply with those standards shall not be approved for installation.
- B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of concrete pipe shall conform to the requirements of ASTM C76 for non-pressurized pipe, latest revision thereof, listed in paragraph 1.03 References of this Section 33 41 00..
- C. Marking:
  - a. The following shall be clearly marked on both the interior and exterior surface of the pipe:
    - a. Appropriate ASTM Specification: ASTM C76 Class and size.
    - b. Date of manufacture.
    - c. Name or trademark of manufacturer.
- D. Diameter of Pipe: The diameter indicated on the Construction Drawings shall mean the inside diameter of the pipe.
- E. Wall Thickness and Class of Pipe: The wall thickness and reinforcing steel shall comply with ASTM C76, Class V, Wall B for non-pressurized pipe. No elliptical reinforcing shall be allowed in any circular pipe.
- F. Fittings and Specials: Fittings and specials shall be made up of pipe segments having the same structural qualities as the adjoining pipe and shall have the interior treated the same as the pipe.

- G. Lifting Holes: Lifting holes will be allowed for pipe provided, however, only two lifting holes per pipe length will be allowed.
- H. Cement: Unless otherwise required by Engineer, or specified otherwise on the Construction Drawings, Type V Sulfate Resistant Portland Cement complying with the requirements of ASTM C150 will normally be acceptable in the manufacture of concrete pipe.
- I. Crystalline Waterproofing Additive (Xypex):
  - a. Products: Xypex crystalline waterproofing materials: Xypex Admix C-500.
  - b. Mixture: Xypex Admix must be added to concrete mix at time of batching.
  - c. Dosage Rate: Under normal conditions, the crystalline waterproofing powder shall be added to the concrete mix 3% by weight of Portland cement content.
  - d. Application: Xypex Admix shall be added to the concrete mix at time of batching. Thorough blending of the Xypex Admix throughout the concrete mix is essential for correct performance of the product and, therefore, care should be taken to ensure that a homogeneous mixture is obtained.
  - e. Concrete Batching & Mixing on Precast Batch Plant for Pan Type Mixer: Add Xypex Admix to the rock and sand, then mix thoroughly for 2 - 3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.
- J. Joints:
  - a. The joint design for concrete pipe shall be bell and spigot or tongue and groove. The bell or tongue shall be of confined gasket or single offset spigot configuration to properly contain and seat the rubber gasket. The joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench the assembled pipe shall form a continuous watertight conduit with smooth and uniform interior surface, and shall provide for slight movement of any piece of the pipeline due to expansion, contraction, settlement or lateral displacement. The gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be in planes at right angles to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be furnished to regular smooth surfaces.



- b. The jointing material used for concrete pipe shall be a rubber-gasketed joint. All joints and jointing material shall conform to the following minimum requirements.

- a) Rubber-Gasketed Joints:

- a. Rubber gasket joints for tongue and groove or bell and spigot pipe using a confined gasket joint shall consist of an O-ring rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM 361, ASTM C443, ASTM C1619, or ASTM C1628 for the pipe designated. Unless otherwise approved by Engineer, the standard joint configuration shall be as noted in Subsection 3.03.E.
  - b. Rubber gasket joints for tongue and groove or bell and spigot pipe using a single offset joint shall consist of a non-circular rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM C76 or ASTM 361 for the pipe designated. Unless otherwise approved by Engineer, the standard joint configuration shall be as noted in Subsection 3.03.E.
  - c. Gaskets may be isoprene or neoprene conforming to ASTM C1619.
- b) Mortared Joints: Mortared joints shall only be used in special circumstances and only where specifically authorized by Engineer. It is the intent of these Specifications to limit the use of mortared joints to the minimum extent possible except where unusual field conditions require deviation from the jointing material specified.

- K. Protective Coatings: Normally, no additional exterior or interior protective coatings shall be required for concrete pipe. However, whenever adverse corrosive conditions warrant additional interior protection, those pipe segments will be noted on the Construction Drawings.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. The pipe and pipe coatings shall be inspected by Owner's Onsite Representative for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

- B. All pipes that do not meet the requirements of Part 2 of this section will be rejected and replaced at Contractor's expense.
- C. Contractor shall install pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the Construction Drawings.
- D. Proper equipment, implements, tools and facilities shall be provided and used by Contractor for safe and convenient installation of the type of pipe being installed.

### 3.02 SURFACE PREPARATION

- A. Comply with applicable requirements of Section 31 10 00 Site Clearing and Section 31 22 00 Site Preparation as acceptable to the Owner's Onsite Representative.
- B. Within Unpaved Roadway Areas: Contractor shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

### 3.03 INSTALLATION

- A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by Owner's Onsite Representative, at times when pipe laying is not in progress.
- B. Pipe:
  - a. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the Construction Drawings.
  - b. Pipe lines shall be laid to the grades and alignment shown on the Construction Drawings. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by Owner's Onsite Representative or Engineer. No deviation from grade shall cause a depression in the pipe invert that could retain fluids or solids.
  - c. Pipe with lifting holes shall be installed such that the lifting holes are in the crown of the pipe. All lifting holes shall be properly

grouted with cement mortar immediately after the pipe is installed and prior to commencement of backfilling.

- d. Pipe with lifting anchors shall be installed such that the lifting anchors are in the crown of the pipe. All lifting anchor recesses in the wall of the pipe at the lifting anchors need not be grouted.

C. Pipe Fittings:

- a. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flow line. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.
- b. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

- D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

- E. Acceptable Joint for this application can be chosen from the following:

- a. Bell And Spigot With USBR M-1 Type R-4 Joint (Confined Gasket) (ASTM C361).
- b. Bell And Spigot With USBR M-1 Type R-2 Joint.

- F. Obstructions not shown on the Construction Drawings may be encountered during the progress of the Work. Should such an obstruction require an alteration to the pipe alignment or grade, Engineer will have authority to order a deviation from the Construction Drawings, or Engineer may arrange for the removal, relocation, or reconstruction of any structure, which obstructs the pipeline.

- G. Joints of precast concrete boxes and precast concrete pipe shall be grouted in accordance with the manufacturer's recommendations or as designated on the Construction Drawings.

### 3.04 BEDDING AND BACKFILLING

- A. Select bedding and backfill material may be required and shall be so shown on the Construction Drawings. Select bedding materials shall conform to the

designated gradation requirements in Section 31 23 33 Trenching, Backfilling and Compacting.

- B. Bedding and backfill material shall be placed under and around all pipes as shown on the Construction Drawings. Bedding and backfill shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding and backfill shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.
- C. Backfill compaction shall not be attained by inundation or jetting. Backfill material shall be uniformly compacted the full depth of the trench.

### 3.05 SURFACE RESTORATION

- A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by Contractor shall be replaced in kind or as shown on the Construction Drawings.

### 3.06 CLEAN UP

- A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION